No. 37-1919.

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British Engineering Standards Association.

(Incorporated 1918).

FORMED IN 1901 AS THE ENGINEERING STANDARDS COMMITTEE

BY THE INSTITUTION OF CIVIL ENGINEERS. THE INSTITUTION OF MECHANICAL ENGINEERS. THE INSTITUTION OF NAVAL ARCHITECTS. THE IRON AND STEEL INSTITUTE. THE INSTITUTION OF ELECTRICAL ENGINEERS.

BRITISH

STANDARD SPECIFICATION

FOR

ELECTRICITY METERS

(REVISED JANUARY, 1919)

LONDON :

PUELISHED FOR THE ABSOCIATION BY CROSBY LOCKWOOD & SON, 7. STATIONERS' HALL COURT, LUDGATE HILL, E.C. 4; AND 5, BROADWAY, WESTMINSTER, S.W. 1, AND TO BE PURCHASED FROM ANY BOOKSELLER, OR DIRECT FROM THE OFFICES OF THE ASSOCIATION, 28, VICTORIA STREET, WESTMINSTER, S.W. 1.

January, 1919.

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† Succeeded the late SIR JOHN WOLFE BARRY, K.C.B., February, 1918.

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BRITISH ENGINEERING STANDARDS ASSOCIATION.

The following are lists of Members of the Sectional Electrical Committee and of the Sub-Committee on Electrical Accessories which was entrusted with the revision of the following Specification :---

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WHICH IS ALSO THE

BRITISH NATIONAL COMMITTEE

OF THE

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The Sub-Committee has been assisted in the preparation of this Revised Specification by Mr. J. W. Beauchamp, representing the I.M.E.A., Mr. F. A. Neild and Mr. R. H. Schofield, representing the B.E.A.M.A., and by Mr. C. C. Paterson and Mr. S. W. Melsom, representing the Director of the National Physical Laboratory.

* President, British National Committee.

+ Hon. Sec., British National Committee.

2 Also nominated by the Institution of Electrical Engineers. ** Since deceased.

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PREFACE TO FIRST EDITION.

The Sub-Committee on Electrical Plant Accessories was appointed at a Meeting of the Sectional Committee on Electrical Plant (Sir William H. Preece, K.C.B., Chairman) held on January 15th, 1903, which appointment was confirmed by the Main Committee on December 8th, 1904.

The Meter Manufacturers accepted the invitation of the Committee to give evidence on the question of Electrical Supply Meters, and on January 7th, 1907, the Sub-Committee sat at the Institution of Civil Engineers to hear this evidence, and most careful consideration has been given to the views expressed by the Manufacturers on this occasion. Information has also been gathered from a large number of Central Station Engineers with reference to the question of accuracy, and the Sub-Committee are much indebted for the very full and careful attention given to their enquiries. The Sub-Committee has had the advantage of the assistance and co-operation of Mr. C. A. Baker, representing the London County Council, in drawing up this Specification. Finally, the Sub-Committee desire to place on record their appreciation of the valuable services rendered by Mr. S. Evershed and Mr. I. Rennie in the difficult task of drafting this Specification, which, if generally adopted, cannot fail to be of great assistance to both User and Manufacturer.

This Report was adopted by the Sectional Committee on Electrical Plant at their Meeting held on July 18th, 1907.

This Report was adopted by the Main Committee at their Meeting held on July 22nd 1907.

C. H. WORDINGHAM,

Chairman of the Sub-Committee on Electrical Accessories.

PREFACE TO FIRST REVISION.

The First Edition of this Specification referred only to Consumers' Meters of sizes up to 100 amperes. When the Revision was undertaken, it was found necessary considerably to extend the scope of the Specification in consequence of the large increase in size of individual installations arising from the extension of the use of electrical energy, supplied from central stations, which has taken place since the original publication.

Requirements for Meters up to the largest sizes in use as well as for three-wire and three-phase Meters, have therefore been added. The question of including the Electrolytic type of Meter has been very carefully considered, but it has not been found desirable to do so at present.

(8)

The Specification is intended to apply to the purchase of new Meters, governing their sale by the Manufacturer to the Purchaser, and it has no direct bearing on any question which may arise between the Supply Undertakers and their Consumers in connection with such of the Meters as are employed to register energy supplied from Public Supply mains. The requirements have, however, been so drawn up that Meters conforming to them may reasonably be expected to fulfil the conditions imposed by the Board of Trade on Meters used in connection with Public Supply Undertakings, and to satisfy Inspectors under the Electric Lighting Acts during a considerable period after the Meters have been put into service.

This Report was adopted by the Sectional Electrical Committee at their Meeting held on July 16th, 1915.

This Report was approved by the Main Committee at their Meeting held on July 22nd, 1915.

C. H. WORDINGHAM,

Chairman of Sub-Committee on Electrical Accessories.

PREFACE TO SECOND REVISION.

During the first revision of this Specification considerable extensions were made to the original Specification issued in 1907, but certain of the clauses in the revised Specification were found to present difficulty, and it became necessary again to revise the Specification.

Careful consideration has been given to the comments from the various Associations represented on the Committee, and it is believed that the present Specification forms a satisfactory basis for a contract for the purchase of new meters. It must be emphasised that the Specification has no direct bearing on any question which may arise between supply undertakers and their consumers in connection with such meters as are employed to register energy supplied from public supply meters, this being a matter for the authority constituted under the Electric Lighting Acts.

The Committee recognise that while alternating current meters can be obtained having considerably greater accuracies than those specified, direct current meters cannot be expected, in the present state of knowledge, to have very much greater degrees of accuracy than those specified; since it seemed illogical to require smaller error in one class than in the other it was decided not to discriminate between them.

This Report was adopted by the Sectional Electrical Committee at their meeting held on 10th July, 1918.

This Report was approved on behalf of the Main Committee on 30th December, 1918.

> C. H. WORDINGHAM, Chairman of Sub-Committee on Electrical Accessories.

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NOTE.—The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the article herein referred to, but does not purport to comprise all the necessary provisions of a Contract.

BRITISH

STANDARD SPECIFICATION

FOR

ELECTRICITY METERS.

STANDARDS AND DEFINITIONS.

British Standards of Electrical Quantities.

1. The British Standards for electrical measurement shall be the Legal Standards in the custody of the Board of Trade, and all electrical quantities referred to in this specification shall be measured in terms of these Standards by means of apparatus which is in agreement with such Standards at the time of use.

Standard Temperature.

2. The Standard Temperature for the purposes of this specification shall be 15° C. unless otherwise marked on the meter.

Indication of Meter.

3. Meters shall register in terms of the legal unit of electrical 20 energy defined as one thousand watt-hours.

Circuit.

4. The term "Circuit" denotes terminals, connecting wires, joints, coils and all other conductors forming a path for an electric current.

Main Circuit.

5. The term "Main Circuit" denotes that circuit which carries the whole current of the supply of which the meter registers the energy.

Meter Current Circuit.

6. The term "Meter Current Circuit" denotes that portion of the main circuit between the terminals of the meter which is contained within the meter case.

Pressure Circuit.

7. The term "Pressure Circuit" denotes that circuit which is 35 traversed by a current proportional to the pressure of supply.

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Meter Pressure Circuit.

8. The term "Meter Pressure Circuit" denotes that portion of the pressure circuit between the pressure terminals of the meter which is contained within the meter case.

Marked Current.

9. The term "Marked Current" denotes the current in amperes marked on the name plate of the meter.

Marked Pressure.

10. The term "Marked Pressure" denotes the pressure in volts marked on the name plate of the meter.

Full Load.

11. The "Full Load" of the meter or of each element, if the meter has more than one element, is the marked current at the marked pressure and at unity power factor.

Rotor.

12. The term "Rotor" denotes that portion of the motor which forms the prime movement of the meter.

Register.

13. The term "Register" denotes the circular scales and pointers, or the figure openings and figure wheels, as the case may 20 be, from which are read the figures that permit evaluation of the supply to the consumer.

Meter.

14. The term "Meter" includes also such auxiliary appliances as resistances, shunts, current and pressure transformers external to 25 the meter in Clauses 15, 34 to 41, 43 to 46, 50, 51, 54 to 57, and the requirements of these clauses apply when all such auxiliary appliances are operating in connection with the meter of which they form part.

Switchboard Meter.

15. The term "Switchboard Meter" denotes a meter fitted with back connections.

SPECIFICATION.

GENERAL CLAUSES.

General Construction.

16. The construction of the meter (*see* Clause 14) shall be mechanically sound and suitable for its purpose, and shall be such as to give reasonable assurance of permanence in all mechanical electrical and magnetic adjustments and shall not be seriously affected by external magnetic fields.

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Case.

17. The parts of the meter within the case shall be carried on a substantial stiff framework forming, if desired, part of the case. The framework shall not be liable to distortion by changes of temperature, presence of moisture or other cause. They shall be 5 completely enclosed in a substantial dust-tight metal case, the front and sides of which may be glazed. The case shall be of sufficient strength to afford adequate protection to the working parts against mechanical injury with reasonable usage, and capable of being sealed in such a manner that access to the working parts and the electric or magnetic adjustments of the meter can only be obtained by breaking the seals.

Care shall be taken to ensure that the mechanism as well as the interior of the case are free from dust or other extraneous matter immediately prior to sealing.

Windows.

18. One or more substantially glazed dust-tight windows shall be provided in the front of the case in such a manner as to give a clear view of the register, and also of those working parts the observation of which is necessary for rapid testing of the meter. It 20 shall be impossible to remove the glass without breaking the seals of the case or breaking the glass itself.

Finish of Case.

19. The case of the meter, together with any framework, shall be protected on the outside and inside from corrosion and de-25 terioration by an efficient coating of paint, enamel, or other suitable material not liable to be damaged by ordinary handling, nor injuriously affected by the action of moisture or by exposure to air under normal conditions of use.

Terminal Compartment.

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20. The terminals of the meter itself, unless of the switchboard type, shall be enclosed by a separate cover suitable for sealing or contained in an external compartment of the case.

Terminals.

21. All meters of sizes above 100 amperes shall be provided 35 with soldering sockets, except where provision is made for coupling with strip or bar connections.

Disconnecting Device for the Pressure Circuit.

22. The pressure circuit shall be connected to the supply side of the main circuit, and a disconnecting device shall be provided in 40 the terminal compartment to enable the pressure circuit to be entirely disconnected from the main circuit, in order that it may be

(12)

supplied with current from a separate source for purposes of testing. The disconnecting device is not necessary where separate terminals are provided for the pressure circuit.

Sealing.

The meter, unless of the switchboard type having 5 23. external connections, shall be provided with separate facilities enabling the purchaser to seal independently the terminal compartment and the meter case. Facilities may also be provided for independent sealing by the manufacturer (See Clause 42).

Levelling.

Every meter, the accuracy of which is affected by small 24. changes in level, shall be provided with means of ascertaining without breaking the seals that it is correctly levelled.

Diagram of Connections.

25. A meter belonging to any one of the classes defined in 15 Clauses 50 and 54 shall have a diagram firmly attached to the inside of its terminal cover or, in the absence of a terminal cover, to some other convenient part of the meter visible from the exterior. Such diagram shall show the connections and give the particulars required in Clauses 50 and 54.

Construction of Circuits.

26. The circuits of the meter shall be capable of carrying full load continuously without injury to any part of the meter, without any permanent change in its accuracy, and without the temperature of any accessible part of the case exceeding 10° C. above the 25 temperature of the surrounding air, except when a shunt is employed in a separate compartment forming an integral part of the meter, when the temperature of any accessible part of the case of such compartment shall not exceed 30° C. above the temperature of the surrounding air.

External Resistances for Pressure Circuit.

Resistances for use in the pressure circuit of the meter and 27. not enclosed in the meter case shall comply with the following requirements :---

(a) Every external resistance shall be completely enclosed 35 in a strong metal or other fire-resisting case.

(b) Every external resistance shall be so constructed that when the marked pressure is applied to the meter and resistance combined, and is maintained continuously, no injury shall be done to any part of the resistance, and the temperature of any 40 accessible part of the case shall not exceed that of the surrounding atmosphere by more than 30° C.

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(13)

(c) Every external resistance shall have the following particulars indelibly marked on a label permanently fixed to the case :—

(i.) The name of the manufacturer of the meter with which the resistance is used.

(ii.) The serial number of the meter with which the resistance is used.

(iii.) The pressure for which the meter and resistance combined are intended.

(iv.) The value of the resistance at the temperature 10 marked on the meter label in accordance with Clause 37.

Insulation.

28. The meter shall comply with the following requirements as regards insulation :—

(a) The insulation resistance between all the electric 15 circuits of the meter coupled together, and the containing case, or other metal not intended to be insulated when the meter is in use, shall be not less than 5 megohms.

(δ) The insulation resistance between the main circuit and the pressure circuit, if any, shall be not less than 2 megohms.

(c) The insulating material between all the electric circuits and the containing case, or other metal not intended to be insulated when the meter is in use, shall withstand, for one minute, an alternating pressure equal to twice the pressure of the circuit for which the meter is intended, with a minimum of 1,000 volts. 25 All the electric circuits shall be coupled together before applying the high pressure.

The insulation resistance shall be measured with a pressure of not less than 200 volts nor more than 500 volts (direct), applied for a sufficient time for the reading of the insulation indicator to 30 become practically steady.

The requirements of (a) and (c) shall apply to all auxiliary apparatus, other than pressure and current transformers^{*}, used with the meter.

Rate of Loss of Energy.

29. The rate of loss of energy in the pressure circuit at marked pressure shall not exceed the values given in the following table:

Meter.	Marked Pressures up to 250 Volts.	Marked Pressures above 250 Volts.
Direct Current	5 watts.	2 watts per 100 volts.
Alternating Current.	2 watts.	1 watt per 100 volts.

For the high pressure tests for pressure and current transformets, 67 British Standard Specification for Transformers for meters and other instruments, (Report No. 81) when such is issued.

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(14)

The rate of loss of energy in the meter current circuit for all meters having a marked current not exceeding 50 amperes shall not exceed ten watts; with the further restriction that the pressure drop shall not exceed two volts.

When the meter has more than one element the above require- 5 ments shall apply to each element independently.

The pressure drop in external shunts for meters of more than 100 amperes shall be in accordance with Clause 52(e).

This clause shall not apply to Switchboard Meters.

Direction of Rotation.

The forward direction of rotation of the rotor, if any, 30. shall be clearly indicated.

Labels.

The meter shall bear a label or labels on the front of 31. the case, effectually secured against removal, and indelibly and 15 distinctly marked with the following particulars :---

- (a) Country of origin.
- (b) Name of the manufacturer of the meter.
- (c) Serial number.
- (d) Type mark.
- (e) The kind of current and system of distribution.
 - For example :---
 - " Direct current."
 - "Alternating current."
 - "3-phase 3-wire."
 - " 3-phase 4-wire."

(f) The maximum current for which the meter is intended, marked on the label as shown in the following table :---

Type of Meter.	Method of Marking.	Example.	
Two-wire	Full load current through the main circuit.	"100 amperes."	30
Three-wire, for direct or single phase alternating current.	2 × the full load current through either of the main circuits.	"2 · 100 amperes."	
Three- or four-wire, two-phase.	2 × the full load current through either of the main circuits.	"2 · 100 amperes."	35
Three- or four-wire, three-phase.	3 × the full load current through either of the main circuits.	3 × 100 amperes."	40

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(15)

(g) The pressure of the circuit for which the meter is intended, marked on the label as shown in the following table :—

Type of Meter.	Method of Marking.	Example.	
Two-wire	The pressure of the cir- cuit to which the meter is to be connected.	" 100 volts."	5
Three-wire, for direct or single phase alternating current.	2 × the pressure between neutral and outer.	" 2 × 230 volts."	10
Three-wire, two-phase	2 × the pressure between phase and neutral.	" 2 × 230 volts."	
Three - wire, three- phase.	$3 \times$ the pressure between phases.	" 3 × 400 volts."	
Four-wire, two-phase	$2 \times \text{the phase pressure}$	"2 × 230 volts."	15
Four-wire, three-phase	3 × the pressure between phases and neutral.	" 3 × 230 volts."	

(h) The frequency of the circuit in periods per second.

(*i*) The number of revolutions of the rotor, if any, corresponding to one kilowatt-hour. This shall be designated as 20 "Revs. per kwh."

(*j*) The information under Clause 37 if required.

(k) If an external resistance is required in the pressure circuit an indication to that effect shall appear on the label.

(l) The ratio of the potential transformer or transformers. 25 This shall be expressed as a fraction in which the denominator shall be the potential on the pressure circuit of the meter itself thus: 6600/110.

(*m*) The ratio of the current transformer or transformers. This shall be expressed as a fraction, in which the denominator 30 shall be the current through the series coils of the meter itself, corresponding with the marked current in the primary of the transformer, thus: 1000/5.

(*n*) If a purchaser's ownership label is required it shall be circular $1\frac{2}{3}$ inch (35 mm.) diameter, and secured firmly to the 35 case by one rivet.

(16)

Size in Amperes.

32. The following shall be the standard sizes of meters (*see* Clause 14):- 2.5, 5, 10, 20, 40, 50, 100, 150, 200, 300, 400, 500, 600, 800, 1,000, 1,500, 2,000, 3,000, 4,000 and 5,000 amperes.

Registering Mechanism.

(This clause does not apply to electrolytic meters).

33. The registering mechanism* of the meter shall be either of the pointer type or of the counter type, and shall comply with the following requirements :—

(a) In the pointer type the pointers shall indicate on cir- 10 cular scales, each divided into ten equal divisions, and the radius of the scales and pointers shall be not less than 0.28 inch (7.11 mm.).

(δ) In the counter type, all the figures visible within the register, except the first,† shall spring quickly into position; 15 the first figure may move continuously. In the case of quickly moving figures each opening shall be sufficiently large to permit clear observation of the figures.

(c) There shall be not less than 5 indices which may be circular scales and/or openings. For figures moving continuously, the openings shall be large enough to permit of two consecutive figures being identified at the same time, but a suitable device shall be used to prevent the figures 9 and 0 from being seen simultaneously. Those indices which indicate lower values than one kw-h. per division shall be made 25 distinctive from the other indices.

Class.	Size. Full load in Kilowatts.	Constants for the Openings or for one Division of the Circular Scales.	30
Ι.	Up to 1.25	100, 10, 1, 1/10, 1/100.	
11.	Above 1.25 and up to 12.5	1,000, 100, 10, 1, 1/10.	
III.	Above 12·5 and up to 125	10,000, 1,000, 100, 10, 1.	35
IV.	Above 125 and up to 1250	100,000, 10,000, 1,000, 1 0 0, 10.	
V.	Above 1250	In multiples of the above.	

(d) The circular scales and/or the figure openings shall conform with the requirements of the following table :—

* Where meters are required to register accurately in the reverse direction this requirement should be specified. \cdot

 $[\]pm$ The "first" figure means the figure having the *figure significance* 40 in the register.

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The terms in which the record is made by the register or dial shall be clearly marked as "kilowatt-hours."

In the pointer type of register each circular scale shall be marked to indicate the number of kilowatt-hours represented by one division of the scale.

In the counter type, one of the openings shall be marked clearly to indicate the value of the indication in that opening.

No other marking of any kind shall be made on the dial plate.

Minimum Running Current.

34. When a current equal to one-hundredth of the marked 10 current of the meter (*see* Clause 14) (or when this is less than one-twentieth of an ampere then one-twentieth of an ampere) traverses its main circuit the rotor shall start and continue running steadily, the pressure circuit, if any, being energised at the marked pressure in phase with the current in the main circuit.

Limits of Error.

35. The error of the meter (*see* Clause 14) at the standard or marked temperature, pressure, frequency and at unity power factor shall not exceed the following values :---

Permissible Limit of Error.					
Load.	Meters without external shunts or transformers.	Meters with external shunts or transformers.			
Full load to one fifth	Per cent. from true reading. + or –	Per cent. from true reading. + or –	25		
full load (inclusive) From one-fifth to one-	2	2.5			
tenth full load At one-twentieth full	2.5	2.5			
load	4.5	5.0	30		

When current or potential transformers or shunts are employed the accuracy specified above shall be obtained with combined calibration.If auxiliary apparatus is to be connected to the transformer or shunt the meter should be calibrated with all such apparatus connected.

Variation of Pressure.

36. If the meter (*see* Clause 14) has a pressure circuit, a variation of 5 per cent, above or below the marked pressure at any load from full to one-tenth shall not cause a change in the rate of registration in respect of such variation of more than one per cent.

(18)

Variation of Air Temperature.

37. If the rate of registration of the meter (see Clause 14) changes more than o'i per cent, for a change of air temperature of 1° C, the meter shall have information regarding the temperature co-efficient marked upon the label in the following manner :--

"Calibrated at....., C. Temp. Coeff. + (or -)% per ° C."

Yariation due to Heating by Main Current.

The change in the rate of registration of the meter (see 38. Clause 1.1) from the time the marked current is switched on to the main circuit to the time at which the rate of registration becomes 10 constant at that current shall not exceed two per cent, ; and the total error in the rate of registration shall not exceed the limits allowed in Clause 35. When testing for compliance with this clause the marked pressure shall have been continuously applied to the pressure circuit, if any, for a period of not less than six hours immediately 15 before the test, and no current in excess of one quarter of the marked current shall pass through the main circuit during that period. In the case of alternating current meters the current shall be in phase with the pressure.

Excess Current.

The meter (see Clause 14) shall not be injured and its 39. accuracy shall not be permanently impaired by a current 25 per cent. in excess of its marked current maintained for a period of one hour, or by the passage of a current in the main circuit not exceeding 30 times the marked current of the meter for a period not exceeding half a second, the rotor, if any, being free to rotate, and the pressure circuit being energised at marked pressure.

Excess Pressure.

40. The meter (see Clause 14) shall not be injured and its accuracy shall not be permanently impaired by the application of a 30 pressure 15 per cent. above the marked pressure for a period of one hour.

Non-Registration with Pressure alone.

41. Every meter (see Clause 14) having a pressure circuit shall not register with its main circuit open when the pressure circuit alone 35 is acting, either when marked pressure is applied or when this pressure is increased to 10 per cent, above the marked pressure.

Sealing by Manufacturer.

42. One or more of the sealing places on the case may be sealed by the manufacturer before the meter is delivered to the 40 purchaser (or his representative) and, in the event of these seals being broken or removed at any time after delivery, the manufacturer shall no longer be under any liability as regards the accuracy of the meter.

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Comparison with Sealed Pattern.

43. Every meter (see Clause 14) purporting to be of a type which has been approved and sealed under the Electric Lighting Acts, in addition to complying with this specification, shall be in conformity with the sealed pattern of that type deposited at the Board 5 of Trade Electrical Standards Laboratory, and the purchaser (or his representative) may require a specimen meter to be submitted to an inspector appointed under the Electric Lighting Acts for examination in this respect.

Latent Defects.

44. If at any time within three years after the date of delivery any defect in material or workmanship shall become apparent in the meter (see Clause 14) the purchaser (or his representative) may return it to the manufacturer, who shall thereupon make good the defect at his own expense.

Impaired Accuracy.

45. If at any time within one year after the date of delivery the meter (see Clause 14) shall be found to be registering with an error in excess of the limits prescribed by this Specification and shall not have been subjected to unreasonable usage,* the purchaser (or 20 his representative) may return the meter to the manufacturer who shall thereupon at his own expense adjust it to register within the prescribed limits.

Independent Tests.

25 46. In the event of any difference between the purchaser (or his representative) and the manufacturer as to the compliance of the meter (see Clause 14) with this specification, either party shall have the right to have it tested by an independent authority to be mutually agreed upon by the parties, or failing agreement, by the National Physical Laboratory, and all the expenses attendant upon such 30 independent testing shall be borne by the party adjudged to be in the wrong.

[If there is any intention on the part of the purchaser or the manufacturer to have any or all meters, under a contract, tested by an independent authority before acceptance, such arrangement should form part of the contract.]

SECTIONAL CLAUSES.

DIRECT CURRENT METERS.

Identification of Terminals.

.10 47. The terminals shall be clearly and indelibly marked so as to indicate the proper direction of the current through the meter. The left hand or bottom terminal, as seen from the front of the instrument, shall be the positive one.

* Unreasonable usage shall imply, amongst other things, mechanical damage, over-running of coils, storage or use in an unduly damp or corrosive atmosphere.

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Speed of Rotation.

48. The speed of the rotor shall not exceed roo revolutions per minute at full load.

Internal Shunts.

49. If a shunt is used with a meter the nature of the connections and the resistance of all contacts shall be sufficiently constant to prevent the meter error being altered.

Diagram of Connections.

50. A diagram in accordance with Clause 25 shall be attached to every meter (see Clause 14) with a pressure circuit, and to every 10 two-wire meter without a pressure circuit intended for currents exceeding 100 amperes.

The diagram for any meter with an external shunt shall show the minimum permissible distance between the shunt and the meter. This minimum distance shall be such that the accuracy of the meter 15 shall not be affected by the magnetic field produced by the current in the shunt and in the conductors carrying the main current.

The diagram for any meter which carries more than 100 amperes through its current circuits shall contain such directions for the correct disposition of the conductors carrying the current to and 20 from the meter, that those errors may be avoided which result from the differences in the magnetic fields produced by placing such conductors in other than their correct positions.

Accuracy of Three-wire Meters on Unbalanced Loads.

51. When the marked current is flowing in one of the two current circuits of the meter (*see* Clause 14) and half the marked current flowing in the other circuit, at the marked pressure, the rate of registration of a meter which purports to be a 3-wire meter shall not change more than 1 per cent, compared with an equivalent balanced load. 30

External Shunts.

52. If a shunt is neither enclosed in the same case as the meter nor structurally a part of the meter it shall comply with the following requirements :----

(a) The shunt shall have the following particulars indelibly 35 marked either on it or on a label permanently fixed to it.

(i.) The name of the manufacturer of the meter with which it is to be used.

(ii.) The serial number of the meter with which it is to be used.

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(iii.) The marked current of the meter and shunt combined.

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(iv.) The pressure drop when carrying the marked current.

(v.) Where it is essential from considerations of accuracy for the shunt to be mounted in a special position this shall be clearly indicated on the shunt.

(b) The maximum observable temperature rise of any part of the shunt, above the temperature of the surrounding air, after carrying the marked current for two hours shall not exceed 75° C.

(c) If the connections between the shunt and the meter 10 are not soldered, terminals shall be provided on both the meter and the shunt exclusively for these connections, and of such a nature that the resistance of the contacts shall be sufficiently constant to prevent the meter error being altered.

(d) The connections between the meter and the shunt shall 15 be marked with the serial number of the meter.

(e) If the marked current of the meter exceeds 100 amperes the pressure drop in the shunt and meter combined, when carrying marked current, shall not exceed 0.25 volt.

ALTERNATING CURRENT METERS.

Speed of Rotation.

53. The speed of the rotor shall not exceed 60 revolutions per minute at full load.

Diagram of Connections.

54. A diagram of connections in accordance with Clause 25 25 shall be attached to every meter (see Clause 14). In addition to giving the necessary information regarding connections the diagram shall show :---

(a) For meters carrying more than 100 amperes in the meter current circuits, the correct disposition of the conductors 30 carrying current to or from the meter, so that those errors may be avoided which result from the differences in the magnetic fields produced by placing such conductors in other than their correct positions.

(δ) For two-element three-phase meters, the correct phase 35 sequence of the supply to the elements. In this case the diagram shall be shown in the form given in the figure, which shows the convention for connecting a two-element three-phase watt-hour meter to a three-phase network, in order to ensure that each element shall have a definite relation to the direction 40 of phase rotation of the system.



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Variation of Frequency.

55. A variation of five per cent. above or below the marked frequency of the meter (see Clause 14) shall not cause a change in the rate of registration in respect of such variation of more than one per cent. at full load.

Yariation of Power Factor.

56. A variation in the power factor of the load from unity to 0.5 (current lagging) when the meter (see Clause 14) is carrying its marked current at the marked pressure and frequency shall not cause a change in the rate of registration, in respect of such power factor 10 variation, of more than two per cent.; and the total error of the meter shall not exceed three per cent, when carrying any current between the marked current and one quarter of the marked current at the marked pressure and frequency, and when the power factor of the load is 0.5.

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The requirements of this clause shall be fulfilled from the time the meter is first switched on to the main circuit until such circuit has been carrying its marked current for one hour.

Correct Registration of Unbalanced Loads.

57. Every polyphase meter (*see* Clause 14) shall comply with 5 the requirements of this Specification, whether the load is balanced or unbalanced, that is to say, its electrical design shall not be based on a method of measurement which assumes that the three-phase load is symmetrical as regards current or pressure or phase angle.

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APPENDIX I.

PRECAUTIONS NECESSARY IN THE ERECTION OF METERS.

Certain precautions should be observed when erecting meters, either for testing purposes or for permanent installation, otherwise the accuracy of the meter may be greatly impaired, and the various Clauses in the Specification dealing with accuracy may be rendered entirely ineffectual.

The following precautions are considered of special importance, but they are not to be taken as constituting complete instructions for the erection of meters.

(a) External Magnetic Fields. Many of the precautions which are necessary arise from the fact that the strength of the magnetic field produced by the currents in the meter coils is not, in comparison with other magnetic fields which may exist in its neighbourhood, sufficiently great to render the readings of the meter independent of 15 the disturbing influence of such fields.

These disturbing influences may arise from any of the following causes, and must be taken account of in selecting positions for meters :---

(i.) A conductor carrying current in some circuit other 20 than that in which the meter is connected.

(ii.) A permanently magnetised iron framework used in the construction of a switchboard, or iron in the neighbourhood of the meter temporarily magnetised by conductors situated near it.

(iii.) Other electrical apparatus carrying current and situated near the meter, especially circuit breakers

(iv.) Unless the instructions required by Clauses 50 and 54 are followed, both in erecting a meter for testing and when installing it permanently, errors may be caused by the magnetic 30 field of the main conductors leading up to the meter itself or to its auxiliary apparatus.

Stray magnetic fields in the immediate neighbourhood of a switchboard are as a rule variable, and hence their influence on the registration of a meter is also variable. In some situations the only 35 means of ensuring accurate registration is to place the meters on a separate panel at a suitable distance from the switchboard proper.

(b) Level and Vibration.—The meter should be fixed level and in a position where vibration will not affect its running at light loads.

(c) *Polarity*.—The polarity marked on direct current meters 40 (see Clause 47) should be adhered to, since in some types the registration is incorrect with reversed polarity. The correct direction of rotation does not necessarily indicate that the polarity is correct.

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(d) Connections to Large Meters.—The accuracy of large current meters or shunts may be seriously affected, unless the resistance of the main contacts is reduced to a minimum by these contacts being clean and well surfaced. Some meters can be put out of adjustment if the heavy connecting leads tend to twist or strain them. The leads to and from the meter or shunt terminals should be supported independently of such terminals and connected in such a manner that they are not strained.

(e) Leads for Shunted Meters. — It is essential that only the leads supplied with the meter, and marked with the serial number of the 10 meter, as required by Clause 52 (d), should be used for connecting it with its shunt.

(f) Temperature.—The accurate registration of some types of direct current watt-hour meters requires that the auxiliary apparatus be subject to the same variations of air temperature as the 15 meter itself. This is more especially the case where an added resistance of copper in the pressure circuit is mounted in a separate box. Positions for erection, therefore, should be selected where no part of the apparatus is liable to be independently heated by an extraneous source of heat or cooled by a draught. 20

(g) Phase Sequence.—Three-phase meters should be so connected to the supply that their elements have the proper relation to the direction of rotation of the system as shown in Clause 54. Provision is made in this clause for the necessary directions to be put on diagrams of connections affixed to meters.

(h) Additional Apparatus connected to Transformers.—The connection to the secondary windings of transformers, of trip coils, animeters and similar additional apparatus in series with the meter coils is liable to affect the rate of registration of the meter. It is, therefore, essential that the meter should be tested and adjusted 30 with all such apparatus connected in circuit, under similar conditions to those which will prevail in practice.

(*i*) Earthing of Secondary Circuits.—A meter for use on pressures exceeding 650 volts should have its case and one point on each of its low pressure windings connected to earth.

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APPENDIX II.

Notes on the Testing of Meters.

These notes are intended to explain some of the conditions to be observed in the testing of meters under this Specification. They are not intended as exhaustive instructions for testing, but deal with a number of cases in which uncertainties might arise regarding the interpretation of a clause, or the correct tests to apply.

(a) Rate of Loss of Energy (Clause 29).—Therate of loss of energy should be determined after both main and pressure circuits have reached a steady state following on the applic tion to them of marked 10 current and pressure respectively.

(b) Minimum Running Current (Clause 34).-In order to ascertain if the rotor continues to run steadily, the test should last long enough for the rotor of motor meters to make at least three complete revolutions. Any vibration of the meter during this test 15 should be avoided.

(c) Limits of Error (Clause 35).—Tests should only be made after the pressure circuit has been energised at marked pressure sufficiently long for the temperature to have reached a steady state as indicated by the constancy of the meter rate at any load. For 20 alternating current meters this period is often less than an hour. In some direct current meters it may be as long as six hours.

(d) Variation of Pressure (Clause 36).—The pressure of five per cent, above or below the marked pressure should be applied for a period long enough to ensure that the meter has reached a steady 25 state. The change in the rate of registration due to change of pressure is the difference between the speed of the meter under this condition, after a steady state has been reached, and the rate of registration at marked pressure. When making these tests on direct current meters the pressure variations from the marked 30 pressure to five per cent, above or below the marked pressure should be gradual and the pressure circuit should not be broken during the period of test.

(e) Variation due to Heating by Main Current (Clause 38).-The time required to reach a steady state may in some meters be as 35 much as six hours.

(f) Excess Current and Pressure Tests (Clauses 39 and 40).-Before measurements are made to determine if there is any permanent change of accuracy after the application of the excess load, the meter should be abowed to reach a normal temperature condition 40 again.

(g) Non-Registration with Pressure alone (Clause 41).—For motor meters the same precautions should be observed as given in (b). For clock type meters a run of several hours is advisable.

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(h) Shunts (Clauses 49 and 52).-To detect the presence in the shunt or in the meter main circuit of any thermal electro-motive force sufficient to affect the accuracy of the meter, the marked current should be maintained through the main circuit for a period of about one hour. If the rotor continues to revolve for more than one complete revolution after switching off, the presence of a thermal E.M.F. is indicated. The above test to detect a thermal E.M.F. can only be used if the meter fulfils the requirements of Clauses 34 and 41.

(i) Variation of Frequency (Clause 55) .- For tests under this 10 clause, the power factor should remain constant for any given determination of change of rate of registration with change of frequency. The power factor of the load at which such determinations are made should be unity. The same precautions are to be observed as given in (c). 15

(i) Variation of Power Factor (Clause 56).- The same precautions are to be observed as given in (c).

No. 37-1919.

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APPENDIX III.

ILLUSTRATIONS OF TYPICAL ARRANGEMENTS OF METER REGISTERS.

The following illustrations show typical arrangements of Meter Registers which would comply with the requirements of Clause 33.



POINTER TYPES.

CLASS I.



CLASS II.



Illustrations of Classes IV. and V. would be exactly similar to those of Class III., except that the scale or opening marked "kw-h or "kw-h. per division" would be marked "10 kw-h." or "10 kw-h. per division" for Class IV., and "100 kw-h." or "100 kw-h. per division" for Class V. (29)

COUNTER TYPES.



CLASS I.



CLASS II.



CLASS III.

Illustrations of Classes IV. and V. would be exactly similar to those of Class III., except that the scale or opening marked "kw h." or "kw-h. per division" would be marked "10 kw-h." or "10 kw-h. per division" for Class IV, and "100 kw-h." or "100 kw-h. per division" for Class V.

British Engineering Standards Association.

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OF

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JANUARY, 1919.

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